High-Density Infrared Heating Improves Productivity in Multiple Industries

Transportation

FOR THE 21ST CENTURY

Background

High-density infrared heating is a fast, precise method of heating metals and other materials that is proving highly successful in industrial applications. Infrared heating is energy efficient, effective, safe, environmentally friendly, and can lead to significant cost savings.

Oak Ridge National Laboratory has established an Infrared Processing Center that offers its users access to a variety of infrared heat-treatment systems. Infrared processing employs tungsten halogen lamps, stabilized plasma systems (the most powerful lamps in the world), and lasers. The heating systems can be devised in a variety of furnace shapes while the plasma-based systems can be used in a scanning mode with robotics at widths as large as 15 inches.

Infrared processes have been developed at ORNL for a variety of applications including joining, preheating, coating consolidation, stress relieving, and composite fabrication.

The Technology

Infrared heating is a clean, non-contact process that ramps to full power in milliseconds and shuts down instantaneously. Precise, controllable heat fluxes allow rapid heating (i.e., 50 to 400°C per second and higher) and "zone" heating. Because only the sample is heated, cooling is rapid. High heat fluxes can be delivered unidirectionally over a large area, allowing control of temperature gradients through thick sections. The shape of the material to be heated does not limit the process, and it couples with most materials.

Infrared heating is proving very effective in the die casting industry where a serious problem is degradation of the tooling used in the process. ORNL has developed coatings and coating processes using high-density infrared heating that have already increased die life by an order of magnitude. Further research is being conducted to extend tool life by an additional order of magnitude, or 100 times. This will substantially decrease energy consumption for remanufacturing of tooling and decrease manufacturing cost by eliminating equipment down time.

Commercialization

ORNL has worked with several industrial partners to develop successful infrared processing applications. Delphi Automotive Steering Systems (Athens, Alabama) has installed six single and two double heat zone infrared boot heaters developed by ORNL. They heat thermoplastic and polymer boots that will be placed on auto components such as steering assemblies and CV joints. The infrared units heat and expand the boots in 4 to 5 seconds, virtually eliminating the force formerly required to install the components. The heating and subsequent cooling of the boot results in a better seal than when boots are forced on without being heated.

An infrared die insert heater fabricated by ORNL has shown outstanding results in field tests for robustness, die life extension, and energy savings. Steel dies used in custom forging and die casting must be preheated to 600°F before being used. Preheating with conventional gas or electric calrod heaters takes up to 4 hours, and gas heating can cause die degradation if it is not done properly. ORNL's infrared heater can preheat dies in less than 20 minutes. It converts electric energy to infrared energy at more than 90% efficiency, almost twice that of commonly used electric calrod-type heaters.

The custom forging and die casting sectors of the forging industry together provide about 1.1 million jobs and contribute more than $13 billion to the U.S. economy annually. Parts produced by forging and die casting are used in applications ranging from automotive, agricultural, industrial, and aerospace equipment to computers and medical implants. Infrared processing promises substantial reductions in energy use and manufacturing costs for those key industries.

Benefits

- **Precise, controllable heat fluxes allow rapid heating of thermoplastics, polymers, and metals**
- **Converts electrical energy to infrared energy at 90% efficiency**
- **Rapid cooling because only the sample is heated**
- **Eliminates some ergonomic problems associated with automotive assembly lines and increases productivity**

Infrared heating of polymer boots has eliminated repetitive stress injuries related to placing the boot on automobile steering assemblies.

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